TRANSLATION

FEDERAL SERVICE ON INDUSTRIAL PROPERTY, PATENTS AND TRADE MARKS (ROSPATENT)
bld. 30-1, Berezhkovskaya nab., Moscow, G-59, GSP-5, Russia, 123995 Telephone (8-499) 240-60-15. Fax (8-495) 234-30-58

To No. 2412-131154RU/5042 of 10.12.2007
(21) Our No. 2005102703/28(003585)

In correspondence, please refer to the application number and report a receipt date of this communication

To "Gorodissky & Partners" Law firm Ltd.,
B. Spasskaya str., 25, stroenie 3, Moscow,
129090, Russia
Patent attorney Yu. D. Kuznetsov, reg. No. 595

FGI FIIP
18 JAN 2008
Department 28

DECISION ON GRANT

A PATENT FOR INVENTION

(21) Application No. 2005102703/28(003585)   (22) Application filing date 04.07.2003

As a result of the substantive examination of the present application for invention, it has been stated that

[ ] the claimed invention

[x] the claimed group of inventions

relates to the objects of patent rights and complies with the patentability conditions stipulated by the Civil Code of the Russian Federation and, in view of this, a decision to grant a patent for the invention has been taken.

A Report on Examination Results is enclosed.

Enclosure: on 7 sheets in 1 copy.

Head   *Signature*   B.P. Simonov

0 0 0 3 8 4 4 0 9 1

REPORT ON EXAMINATION RESULTS

(21) Application No. 2005102703/28(003585) (22) Application filing date 04.07.2003

(24) Date from which the patent will be valid 04.07.2003

(85) Date of consideration commencement for the International application in the national phase 04.02.2005

PRIORITY IS SET ON THE DATE OF:

[ ] (22) filing the application
[ ] (23) filing additional materials to the earlier application No.
[ ] (62) [ ] priority of the original application No. from which the present application has been divided up
[ ] filing the original application No. from which the present application has been divided up
[ ] (66) filing the earlier application No.
[x] (30) filing the priority application(s) in the Paris Convention Member Country

	(31) priority application number	(32) priority application filing date	(33) Country code	Claims
1.	0310344.7	06.05.2003	GB	

(86) PCT-Application PCT/GB03/02903 of 04.07.2003

(87) PCT-Application publication number and date WO2004/005844 of 15.01.2004

(72) Inventor(s) MILES Mervyn John, HUMPHRIS Andrew David Laver, HOBBS Jamie Kayne, GB

(73) Patentee(s) UNIVERSITY OF BRISTOL, GB

(54) Title of invention SCANNING PROBE MICROSCOPE

As a result of the substantive examination of the application as conducted with respect to [ ] the original set of claims [x] the set of claims amended by the Applicant, the concordance of [ ] the claimed invention [x] the claimed group of inventions to the requirements of the Articles 1349 and 1350 of the Civil Code of the Russian Federation has been revealed.

The set of claims is presented in page(s) 3 – 6.

(21) 2005102703/28

(51) IPC

G01N 13/10 (2006.01)
H01J 37/28 (2006.01)
G12B 21/00 (2006.01)

(57)

1. A scanning probe microscope (10, 50) for imaging a sample (12) in accordance with an interaction between the sample (12) and a probe (20, 54), the microscope (10, 50) being arranged, in operation, to carry out a scan of the sample surface, and comprising:

a driving means (16, 18, 22) arranged to provide relative motion between the probe (20, 54) and the sample surface and capable of bringing the sample (12) and probe (20, 54) into close proximity, sufficient for a detectable interaction to be established between them,

a means (22, 52) for oscillating either the probe (20, 54) or the sample (12),

a probe detection mechanism (24, 56, 58) arranged to measure at least one parameter indicative of the strength of the interaction between the probe (20, 54) and the sample (12), and

a feedback mechanism (26) arranged to provide for adjustment of probe-sample separation distance via operation of the driving means (16, 22) in response to a variation in an average value of one of said parameters away from a predetermined set value,

characterised in that the means (22, 52) for oscillating provides relative oscillatory motion of the probe (20, 54) across a surface occupied by the sample such that the probe effects a substantially linear sweep of the sample surface wherein, during the scan of the sample surface, scan area is covered by an arrangement of scan lines, each scan line being collected by oscillating either the probe (20, 54) or the sample (12) at or near its resonant frequency such that twice the oscillation amplitude is equal to a maximum scan line length and their arrangement is provided by operation of the driving means (16, 22).

2. A microscope according to claim 1, characterised in that the probe is metallic and the parameter indicative of the interaction is capacitance of an interface between probe and sample.

3. A microscope according to claim 1, characterised in that the parameter indicative of the interaction is oscillation amplitude.

4. A microscope according to claim 2, characterised in that a second parameter indicative of the interaction, and the one on which the feedback mechanism (26) operates, is oscillation amplitude.

5. A microscope according to claim 2 or claim 4, characterised in that the probe detection mechanism (24, 56, 58) comprises a modulation signal generator (48) arranged to apply a modulating voltage across the interface between probe (20, 54) and sample (12) in order to modulate its characteristics and thereby to affect its electrical capacitance, a resonator (42) arranged to set up a resonating electric field in a circuit incorporating the probe (20, 54) and sample (12) and a detector (46) arranged to measure the electric field resonant frequency and thereby to enable variations in the capacitance of the interface to be measured as the modulating voltage is applied.

6. A microscope according to claim 1, characterised in that the probe (20) is adapted to interact with a magnetic field and the probe detection mechanism (24, 56, 58) is arranged to measure a parameter indicative of the magnetic interaction between the probe (20, 54) and the sample (12).

7. A microscope according to claim 1, characterised in that the probe (20) comprises a cantilever and actuator arranged to drive the cantilever in a "tapping" mode.

8. A microscope according to claim 7, characterised in that the parameter indicative of the strength of the interaction is bending of the cantilever as it taps the sample (12).

9. A microscope according to claim 1, characterised in that the probe (54) is an AFM cantilever and the one of said parameters indicative of the strength of the interaction that is measured by the probe detection mechanism (24, 56, 58) and used by the feedback mechanism (26) is bending of the probe (54).

10. A microscope according to claim 9, characterised in that the probe detection mechanism (24, 56, 58) comprises an interaction detection mechanism (56) arranged to measure at least one parameter indicative of the strength of the interaction between the probe (54) and the sample (12) and a deflection detection mechanism (58), the deflection detection mechanism being linked to the feedback mechanism (26) and arranged to measure bending of the probe (54).

11. A microscope according to claim 9 or claim 10, characterised in that the probe (54) comprises an actuator arranged to drive the cantilever in "tapping" mode.

12. A microscope according to any one of claims 1 to 4, characterised in that the driving means (22) is arranged to oscillate the probe (20).

13. A microscope according to claim 12, characterised in that the driving means (22) includes a tuning fork.

14. A microscope according to any one of claims 1 to 4, characterised in that the means (22, 52) for oscillating either the probe or the sample is arranged to oscillate the sample (12).

15. A microscope according to claim 14, characterised in that the means for oscillating the sample is a tuning fork (52) and the sample (12) is attached thereto.

16. A microscope according to any one of claims 1 to 4, characterised in that the feedback mechanism (26) operates with a time constant which is greater than one cycle of probe oscillation and significantly less than total time taken to perform a scan.

17. A microscope according to claim 12, characterised in that the probe is oriented substantially vertically and the driving means (16, 22) is arranged to provide a relative linear translation of probe (20) and sample (12) in a direction substantially orthogonal to a plane in which the probe is oscillated, thereby defining a substantially rectangular scan area.

18. A microscope according to claim 12, characterised in that the probe is oriented substantially horizontally and the driving means (16, 22) is arranged to provide a relative linear translation of probe (20) and sample (12) in a direction substantially parallel to the oscillation axis, thereby defining a substantially rectangular scan area.

19. A microscope according to claim 12, characterised in that the probe is oriented substantially vertically and the driving means (16, 22) is arranged to provide a relative rotation of probe (20) and sample (12) about an axis substantially coincident with that about which the probe (20) is oscillated, thereby covering the scan area by a circular arrangement of scan lines.

20. A microscope according to any one of claims 1 to 4, the microscope being adapted to monitor charge distribution in a semiconductor device.

21. A method of rapidly collecting image data from a scan area of a sample (12) with nanometric features wherein the method comprises the steps of:

(a) moving a probe (20, 54) with tip of sub-nanometric dimensions into close proximity with a sample (12) in order to allow an interaction to be established between probe (20, 54) and sample (12),

(b) oscillating either the probe (20, 54) across the surface of the sample (12) at or near its resonant frequency or the sample (12) beneath the probe (20, 54) at or near its resonant frequency, said oscillation being such that the probe effects a substantially linear sweep of the sample surface, whilst providing a relative motion between the probe (20, 54) and surface such that an arrangement of scan lines, whose maximum length is equal to twice the oscillation amplitude, covers the scan area,

(c) measuring a parameter indicative of the interaction strength,

(d) monitoring the parameter measured in step (c) or a second parameter which is also indicative of an interaction between probe (20, 54) and sample (12) and, if a value of the monitored

parameter falls below or rises above a predetermined set value, adjusting probe (20, 54) - sample (12) separation distance in order to drive the value of the monitored parameter back towards the set value, and

(e) processing measurements taken at step (c) in order to extract information relating to the nanometric structure of the sample.

22. A scanning probe microscope for writing information to a sample by means of an interaction between the sample and an AFM cantilever probe, the microscope comprising:

a driving means arranged to provide relative motion between the probe and the sample surface and capable of bringing the sample and probe into close proximity,

a means for oscillating either the probe or the sample,

a probe writing mechanism arranged to vary intermittently, on a timescale shorter than one period of probe or sample oscillation, the strength of the interaction between the probe and the sample and so to change intermittently a property of the sample surface in the locality of the probe,

characterised in that the means (22, 52) for oscillating provides relative oscillatory motion of the probe (20, 54) across a surface occupied by the sample such that the probe effects a substantially linear sweep of the sample surface,

wherein the microscope is arranged, in operation, to carry out a writing scan of the sample surface wherein scan area is covered by an arrangement of scan lines, each scan line being collected by oscillating either the probe (20, 54) or the sample (12) at or near its resonant frequency such that twice the oscillation amplitude is equal to a maximum scan line length and their arrangement is provided by operation of the driving means.

23. A scanning probe microscope for writing information to a sample according to claim 22, characterised in that the microscope also includes a probe detection mechanism arranged to measure at least one parameter indicative of the strength of the interaction between the probe and the sample and a feedback mechanism arranged to provide for adjustment of the probe-sample separation distance via operation of the driving means in response to a variation in an average value of one of said parameters away from a predetermined set value, the average value being taken over a time interval greater than that of one period of probe or sample oscillation.

(56) US 6220084A, 24.04.2001,
US 6404207A, 11.06.2002,
SU 1531181A1, 23.12.1989,
RU 2109369C1, 20.04.1998,
KR 20010068003, 13.07.2001.

The specification amended by the Applicant (substituted pages 3-12) and the original drawings shall be used in publication of information on granting the patent.

Enclosure: abstract amended by the Examiner on 1 sheet in 1 copy.

State Senior Patent Examiner
of the Measurement and
Instrument-Making Department *Signature* E. F. Andreychenko
8-499-243-76-98

Enclosure to Decision on Grant a patent for invention

To the application No: 2005102703/28

(54) SCANNING PROBE MICROSCOPE

ABSTRACT

(57) A scanning probe microscope comprises a driving means providing for a detectable interaction between a probe and a sample, a means for oscillating either the probe or the sample, a probe detection mechanism, and a feedback mechanism providing for adjustment of a probe-sample separation distance. The oscillating means provides for relative oscillatory motion of the probe across a surface occupied by the sample such that the probe effects a substantially linear sweep of the sample surface. During the scan of the sample surface, scan area is covered by an arrangement of scan lines, each scan line being collected by oscillating either the probe or the sample at or near its resonant frequency such that twice the oscillation amplitude is equal to a maximum scan line length and their arrangement is provided by operation of the driving means. A more rapid collection of a data about sample-probe interactions and thereby an increase in information readout or write rates are provided. 3 indep. claims, 20 dep. claims, 3 Figs.

Reviewer E. F. Andreychenko